in which it should be set forth that in taking measurements under the arm the thermometers should be allowed to lie for five minutes before the reading is taken.

MESSRS. SCHEEL AND HEUSE have published in the February number of the *Zeitschrift für Instrumentenkunde* the results of some investigations undertaken by them on the methods of producing high vacua. The tests were carried out on the Gaede pump, the Toepler pump, Reden and Rosenthal's mercury pump, and on charcoal in liquid air used in connection with the air pump. The resultant pressures were measured by the McLeod vacuum gauge, the authors having found (*Verhandlungen der deutschen physikalischen Gesellschaft*, vol. xi., p. 1) that this method could be applied for the measurement of the lowest pressures. The most important result was that obtained by employing charcoal prepared from cocoa-nut shell, and using this charcoal, in liquid air, in conjunction with an air pump (Gaede's), the initial pressure of 0·006 millimetre being derived from the pump. A vacuum of 0·00001 millimetre was obtained and kept up for some time by this method. Complete tables of readings, and a full description of the experiments, are given in the article.

AN interesting report of trials on a complete steam plant at the Greenvale Mill, Littleborough, near Manchester, is given in *Engineering* of February 26. The trials were made under the direction of Mr. G. B. Storie, consulting engineer, of Rochdale, and his report is of special interest on account of the very full results given. The plant includes a Brush-Parsons parallel-flow steam turbine developing 500 kilowatts at 3000 revolutions per minute and 200 lb. per square inch steam pressure. Mr. Storie finds its thermal efficiency at 91·8 per cent. of the rated power to be 18·27 per cent., the efficiency ratio by comparison with the Rankine cycle being 0·579. It is unusual to find a report on a steam turbine containing information regarding the pressure, temperature, and degree of superheat of the steam at the end of each stage of the expansion, and it would be very useful if other experimenters would take Mr. Storie's report as an example in this respect. There has been a tendency to withhold such information in the past. Special attention may be directed to the following table of results showing the importance of maintaining a good vacuum with steam-turbine plants:—

Barometer, 29·29 *inches*.

Steam pressure at entrance to turbine—lbs. per sq. inch	163	163	164	161	162	156	157	158
Steam temperature at entrance to turbine—degrees F. .	524	526	530	530	533	512	528	530
Vacuum—inches of mercury	28·29	27·1	26	25·15	24·05	23	22	21
Kilowatts	275	275	276	275	273	270	270	263
Pounds of steam consumed per kilowatt-hour	18·54	19·63	20·65	21·63	22·34	23·33	23·7	24·25

A PAPER on some recent grain-handling and storing appliances at the Millwall Docks, by Mr. Magnus Mowat, read before the Institution of Civil Engineers on March 2, contained some interesting facts about grain elevators. The installation now provides for the discharge and weighing of 550 tons of grain per hour *ex* ship, and for its delivery either partly or wholly into granary, silo, or barge. The elevators which come in contact with the ship's hold are of the pneumatic or suction type. The granary and silo elevators are of the bucket type, and, like the band-conveyers, are of two-ply woven cotton, impregnated with rubber. These bands have a total length of 2¼ miles; they are electrically driven. In the waterway there is a dolphin, alongside which the ship is moored. This is a wooden jetty of greenheart timber, 350 feet by 24 feet, placed 50 feet clear of and parallel with the quay. On its deck are four suction elevators, each of 75 tons per hour capacity, corresponding with the respective holds of the ship. The machinery within the dolphin includes four pairs of exhauster pumps, each 46 inches diameter by 60 inches stroke, which maintain in the grain-receivers on the top of the towers a partial vacuum of 7 inches to 10 inches of mercury. Flexible pipes connect the receiver with the ship's hold, and the grain is elevated to a height of 80 feet by the inrushing air, the proportion of air being controlled by nozzles with adjustable sleeves. The grain separates itself from the air in the receiver, and automatically discharges through "tippers" at the bottom of the chamber into hoppers which feed the weighing machines. These deliver through steel shoots into barges, or connect with the quay by band-conveyers on bridges spanning the intervening water-space. The band-conveyers within the granary and subways under the quay are endless, and are supported at 6-feet intervals by steel rollers on cast-iron standards, tied longitudinally by steel angles on each side; their speed is 552 feet per minute. The bands and elevators form a series for mechanically conveying the grain from the dolphin elevator to the roof of the granary, from which it is distributed to the various floors by gravity through pipes provided with sleeves and doors for housing and delivery to or from any section.

WE have received from Messrs. John Wheldon and Co., of Great Queen Street, London, W.C., a copy of their latest catalogue of geological works, containing particulars of 1761 publications they have on sale. The books concerned include selections from the libraries of the late Prof. Ramsay, Dr. R. Hunt, Prof. J. Percy, Prof. Phillips, Mr. William Topley, and Dr. Flight.

MR. FRANCIS HODGSON has published the sixth volume of the second series of the Proceedings of the London Mathematical Society. The record deals with meetings of the society held from November, 1907, to June, 1908, and the papers read on these occasions, short abstracts of which have appeared already among our reports of societies and academies. The volume also contains obituary notices of the late Lord Kelvin and Mr. C. Taylor.

OUR ASTRONOMICAL COLUMN.

ANOMALOUS REFRACTION AND SPECTROHELIOGRAPH RESULTS.—Having spent some time, in August, 1907, at the Mount Wilson Observatory, and having employed the splendid equipment there in a number of experiments, Prof. Julius has derived further confirmation of his theory that some of the phenomena seen on various spectroheliograms are, at least in part, due to the anomalous refraction which waves from the vicinity of absorption lines must suffer when passing through an absorbing medium of varying densities. The experiments and the results obtained are described and discussed in No. 5, vol. xxviii., of the *Astrophysical Journal*.

By selecting lines at different distances from the sodium, D, lines, and passing the rays through a tube containing sodium vapour, in which the density gradients could be controlled, Prof. Julius was able to obtain photographs showing the effects of anomalous refraction, and he shows that equivalent conditions probably exist in the solar atmospheres. Should the further work which is to be carried out on these lines prove confirmatory, it will no longer be necessary to explain "dark" and "bright" flocculi by the assumption of very marked differences in the absorbing and emitting conditions of a certain gas or vapour in contiguous regions on the sun, for the anomalous refraction

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caused by the existence in the sun of irregular density-gradients, comparable in magnitude with the vertical gradient in the earth's atmosphere, will explain them efficiently.

The Constitution of the Sun.—In No. 1, vol. xxix., of the *Astrophysical Journal*, Herr J. F. Hermann Schulz again brings forward the theory that the nucleus of the sun is in a liquid state. This theory, in its earlier forms, was propounded by Kirchhoff, modified by Zöllner, and, about twenty years ago, advocated by Herr Schulz, but the prevailing ideas concerning the sun's temperature then rendered it improbable.

However, in the light of the recent researches of Moissan and others, from which it may be deduced that the mean temperature of the sun is about 5400° C., Herr Schulz believes that a liquid nucleus best explains the observed phenomena, and on these lines he revives his theory. He further argues that various stellar phenomena may be explained on the assumption that many stars, too, are not entirely gaseous. The paper in which the discussion was included was read before the last meeting of the Astronomische Gesellschaft in Vienna, September, 1908, and also appears as an abstract from the *Vierteljahrsschrift der Astronomischen Gesellschaft*, part iv., 1908.

Still another solar theory is expounded in No. 4305 of the *Astronomische Nachrichten*. In this paper M. A. Amaftounsky, of Kichineff, explains the phenomena of sun-spots, metallic and gaseous prominences, sun-spot zones, &c., on the assumption that spots are caused by the outrush of heated vapour from the sun's lower atmosphere, and the filling in of the funnels thus formed by the photospheric clouds. The agreement of observed phenomena with the phenomena which would follow were the theory correct is discussed in detail.

Radial Velocity of α Persei.—From thirty-seven spectrograms of α Persei, taken by Prof. Küstner and Dr. Zurhellen between August, 1904, and March, 1906, Herr F. Goos has derived values for the radial velocities of the star during that period. Previous observers have found that the variation of the velocity is small or non-existent.

In the present investigation Herr Goos made eight settings, each way of the plate, on twelve iron lines which are taken as standards, and found that the velocity, relative to the sun, varied between −3·65 km. and 0, the probable error for each plate being ±0·40 km. (*Astronomische Nachrichten*, No. 4300, p. 50).

A Catalogue of 1625 Southern Stars.—Vol. ii. of the "Meridian Observations of the Perth Observatory (W. Australia)" contains the results of the meridian observations of 1625 stars between 39° and 41° south declination. As explained by Mr. Ernest Cooke, the director of the observatory, in the introduction, these results form part of the scheme undertaken by the Perth Observatory to determine, from time to time, the accurate positions of some 8000 stars lying in the zone 31°–41° S. declination. The positions now given are reduced to the equinox of 1900·0 at the epoch of observation, and, when known, the proper motions, for reduction to epoch, are also given.

The Melbourne Observatory.—Mr. Baracchi's report of the work done at the Melbourne Observatory during the period 1906 December 1 to 1908 April 30 shows that the observatory is, apparently, now well established as a purely astronomical institution, the meteorological work having been transferred to the new Weather Bureau, under the Commonwealth Government, from the end of 1907.

The long-vacant post of chief assistant has now been filled by Mr. J. M. Baldwin, an 1851 Exhibition scholar, who has further qualified for the post by visiting and working at a number of English, Continental, and American observatories.

Mr. Baracchi reports, concerning the astrographic chart work, that, to April 30, 1908, 707 Sydney plates, containing 430,468 stars, and 991 Melbourne plates, containing 318,025 stars, were completely measured. The report concludes with a strong recommendation that, in accordance with the suggestion of the Solar Union, supported by the Royal Society, a solar physics observatory should be founded in Australia, preferably at Adelaide.

SCIENTIFIC AID FOR THE BRITISH TENANT FARMER.

THE various agricultural colleges founded or subsidised by the county councils take a wide view of their functions, and not only give instruction in agriculture to young men wishing to take up this subject, but also carry out field experiments designed to instruct those who are already farming, and who will not or cannot attend lectures. The field experiments are not strictly in the nature of research work, since they do not usually involve any new principles; they are not always arranged to give all the results they might, but, taken as a whole, they serve the very useful purpose of demonstrating to the farmer certain facts which he ought to know, but often does not, and of giving him opportunities of seeing for himself the effect of special manures on crops or of special feeding stuffs on animals.

The results of the field trials are published in pamphlet form by the college or department concerned, and widely distributed among the farming community. Recently the Board of Agriculture started a summary of these reports in its journal, and the idea is a very useful one. The South-Eastern Agricultural College publishes its reports in the form of an annual journal, while the University of Cambridge has periodically brought out full reports dealing with the whole of its experiments in the counties.

In the nature of the case, many of the reports issued are of local rather than of general interest, and do not call for any full treatment here, but a few instances may be quoted to show the type of work being done. Experiments at the University College of Wales, Aberystwyth, have been made to find out what ration will prove profitable for fattening bullocks. The fact that animals require a tolerably large maintenance ration (*i.e.* that they eat a fair amount of food without gaining in weight) renders it necessary that fattening should be rapid, but the difficulty then arises that a large ration gives proportionately less increase in weight than a small one. Up to a certain point an increase in the ration is profitable; beyond this point the profit gradually decreases, and loss arises. Prof. Jones has illustrated these facts very well in the report before us.

The Northumberland experiments deal with pasture problems. It has been demonstrated that basic slag is the most effective manure for economically improving the heavy soils of Northumberland, and a mixture of basic slag and a potash manure is best on the lighter soils. It has also been shown that second, and even third, dressings of slag are quite as effective as the first. The mangel experiments have shown that nitrate of soda gives better results than sulphate of ammonia, that slag is more effective than superphosphate, that sulphate of potash is better than the muriate, and that common salt much increases the crop. Experiments on other crops are also recorded.

Rather different results were obtained in the Scotch experiments on pastures summarised by Mr. Hendrick. Basic slag led to an improvement, but not much, and three or four years elapsed before sufficient return was obtained to pay for the slag. However, the improvement lasts, and can be seen six years afterwards, so that the method is profitable. No other manure was found to give profitable returns. This report gives analyses of the soils, and is therefore much more interesting than those in which soil analysis is ignored.

The West of Scotland Agricultural College has issued reports by Prof. McAlpine. The experiments on varieties of oats made during the years 1902–7 are summarised, and the effect of manures is discussed. Manuring has but little influence on the kernel weight, and only very slightly increases the proportion of kernel to husk.

The Lancashire County Council experiments were designed to test the relative value of limestone and of burnt lime for improving pastures, and the conclusion is drawn that limestone is the more effective, provided it contains 95 per cent. of calcium carbonate and is ground to a sufficiently fine state.

The farmer has not only to produce crops and beasts but to sell them, and success in one branch of his pro-

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